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ABSTRACT

Whether common standards exist among the national standards for kindergarten through grade 12 mathematics, science, and civics and government was studied. Common standards were explored among "Curriculum and Evaluation Standards for School Mathematics," produced by the National Council of Teachers of Mathematics, the "National Science Education Standards," drafted by the National Committee on Science Education Standards and Assessment, and the "National Standards for Civics and Government," proposed by the Center for Civic Education. Through qualitative analyses of each of the publications and supporting literature, a set of eight K-12 exit outcomes was synthesized. How the national standards correlate with these outcomes is discussed, and fundamental evaluation standards are suggested to accompany the exit outcomes. These exit outcomes, like the national standards, focus on essential skills, abilities, and behaviors, to participate and communicate effectively within and among the disciplines and to make use of technological advances to facilitate learning. A 10-item annotated bibliography is attached. (SLD)

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

A Project Paper Presented to
Dr. Jerry Harmon
and the Graduate Faculty
Northern State University

by

Alan E. Uher

July 1994

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APPROVAL SHEET

This project paper is submitted by Alan E. Uher in partial fulfillment of the requirement for the Master's degree at Northern State University, Aberdeen, South Dakota, and is hereby approved by the faculty sponsor under whose direction the study was made.

Project Sponsor Dr. Jerry Harmon

Date July 22, 1994

Standard Procedure

Alan E. Uher

PROBLEM: The major purpose of this study was to determine if a set of common standards exists among the national standards for K-12 mathematics, K-12 science, and K-12 civics and government. The researcher attempted to find common standards among *Curriculum and Evaluation Standards for School Mathematics* (produced by the National Council of Teachers of Mathematics), the *National Science Education Standards* (drafted by the National Committee on Science Education Standards and Assessment), and the *National Standards for Civics and Government* (proposed by the Center for Civic Education).

METHOD: Through qualitative analyses of each of the publications and appropriate supporting literature, the researcher synthesized a set of eight K-12 exit outcomes, cited how the national standards correlate with these outcomes, and suggested fundamental evaluation standards to accompany the exit outcomes.

RESULTS: The exit outcomes, like the national standards, focus on essential skills, abilities, and behaviors, to effectively participate and communicate within and among the disciplines and make use of technological advances to facilitate learning. It was the intent of the researcher to benefit educators, who may not read the national standards, by providing a concise set of general exit outcomes which could influence instruction in the K-12 disciplines of mathematics, science, and civics and government.

It is recommended that a future study further develop standards by which the exit outcomes might be evaluated.

PROJECT SPONSOR: Dr. Jerry Harmon

DATE OF COMPLETION: July 22, 1994

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Chapter One

Introduction

Recently the United States Government, with the supervision of the Department of Education and its supporting agencies, initiated sets of national educational standards for mathematics, science, and civics and government. Through these national standards the Department of Education intended to set educational visions, goals, and objectives for students at the kindergarten through twelfth grade levels. The national standards are now in published forms; however, the science and the civics and government standards are currently under revision. These national standards have emerged following countless hours of collaboration among educators, administrators, and national review boards.

Though the documents suggest radical changes in curriculum content and evaluation procedures, and though they promote the practical application of these disciplines at all grade levels, few are putting the standards to use. Due to the sweeping changes that are presented in the documents, as well as the detailed descriptions of some of the standards, the documents are lengthy and somewhat intimidating for individual educators to read and subsequently implement in their classrooms or districts. It stands to reason that the endeavors which have taken place in assembling and publishing the national standards deserve the attention of all educators and administrators, as well as their commitment to implement them within their respective districts and schools.

Many changes have been suggested, and teachers and administrators alike may abandon their attempts to implement so many new ideas at one time. This researcher perceived a need to put the national standards before the people in a format that was both palatable and concise. The exit outcomes synthesized as a result of the qualitative analysis

of the national standards are one way that educators and administrators could fulfill one set of overriding student outcomes and thus fulfill the spirit or intention of the national standards.

Rationale

"We are not paying enough attention to the integration of the curriculum associated with the various standards" (Evans, 1994). Thus speaks the staff director for the Subcommittee on Education, Arts and the Humanities of the United States Senate. The authors of the 5-8 mathematics standards have this to say about the present manner in which mathematics instruction takes place. This writer feels that the disciplines of science and civics and government could easily fit into this quote as well. "The current curriculum excludes many students from appreciating the useful, exciting, and creative aspects of mathematics. The . . . standards outline a curriculum that attempts to give all students the opportunity to appreciate the full power and beauty of mathematics and acquire the . . . knowledge and intellectual tools necessary for its use in their lives."

According to *Trends in Academic Progress*, a publication of the National Center for Education Statistics, performance in science for nine-, thirteen-, and seventeen-year-olds declined in the 1970's and improved in the 1980's. In 1990, science achievement was at the same level at ages nine and thirteen as it was in 1970. Science achievement in 1990 was lower than in 1969 for seventeen-year-olds. The publication also reveals the educational statistics for math; however the mathematics performance statistics are not nearly as grim. Legislators have set goals that American students are to be first in the world in mathematics and science by the year 2000. Although this Herculean labor may be more ideal than realistic, this writer senses that the American public possesses an innate desire for its children to learn, know, understand, and be able to communicate mathematics and science. Those individuals who drafted the national standards for civics and government

have as an overriding goal the desire for the American educational system to produce an informed electorate, one that is capable of evaluating information and making educated decisions.

The national standards are not mandates. They are suggestions for systemic change to improve the quality of education American children are receiving. The writers of the standards issue a nationwide challenge to educators and administrators to collaborate and make use of the national standards, so that the learning of mathematics, science, and civics and government at the elementary, middle, and secondary levels is improved.

"The key to achieving systemic change is in the building of strong collaborative partnerships which provide a model for continued input, direction, assessment, and support from all levels of educational enterprise " (Benchmarks, 2). It is the intent of this researcher to further encourage American educators to make use of the national standards for mathematics, science, and civics and government, as put forth by the "Standard Procedure" exit outcomes.

Description of Project

The researcher assumed the charge of addressing this question: Is it possible to correlate the educational standards for math based on *Curriculum and Evaluation Standards for School Mathematics* (produced by The National Council of Teachers of Mathematics), the *National Science Education Standards* (produced by the National Committee on Science Education Standards and Assessment), and the *National Standards for Civics and Government* (drafted by the Center for Civic Education), so that elementary, middle school, and secondary teachers can fulfill one set of standards that will satisfy the commonalities among the national standards?

In order to fulfill this charge, the researcher read the three documents listed above and supplemented them with *South Dakota Mathematics and Science Benchmarks* (produced by the South Dakota National Science Foundation Systemic Initiative); *Trends in Academic Progress; Can Students Do Mathematical Problem Solving?; Promising Practices in Mathematics & Science Education;* and *Mathematics, Science & Technology Programs that Work.* (The four latter publications have been prepared and/or sponsored by the United States Department of Education.)

The researcher then qualitatively analyzed the national standards for mathematics, science, and civics and government to generate a list of standards common to the government-initiated standards. It was the intent of the researcher that such analysis would benefit him personally in his own classroom teaching. The researcher also noted a possible benefit for other educators who might be interested in fulfilling the national standards without having to read the documents themselves.

During the research process, the researcher saw the necessity to generate evaluation standards to accompany the exit outcomes. Due to the far-reaching nature of this task, the researcher has provided the fundamental bases for the evaluation standards.

Definitions

In order for the reader to more fully appreciate the terminology involved in this research, following are several terms and their intended definitions as they pertain to the topic under study.

CURRICULUM: A *curriculum* is an operational plan for instruction that details what material from a discipline students need to know, how students are to achieve the identified curricular goals, what teachers are to do to help students develop their knowledge, and the context in which learning and teaching occur. (National Council of Teachers of Mathematics, *Curriculum and Evaluation Standards for School Mathematics*)

EVALUATION: Standards which have been articulated for evaluating both student performance and curricular programs, with an emphasis on the role of evaluative measures in gathering information on which teachers can base subsequent instruction. Evaluation also includes measuring student growth and achievement for research and administrative purposes. (National Council of Teachers of Mathematics *Curriculum and Evaluation Standards for School Mathematics*)

GOALS: The term *goals* is used to refer to refer to general statements of the overarching aims or ends of education. (Center for Civic Education, *National Standards for Civics and Government*)

STANDARD: A *standard* is a statement about what is valued and against which curriculum evaluation is judged. (National Council of Teachers of Mathematics, *Curriculum and Evaluation Standards for School Mathematics*)

BENCHMARK: A *benchmark* sets the vision for student learning, as it describes what students should be able to do as a result of the educational experiences that have been designed, developed, and facilitated by their teachers. Benchmarks focus not on content, but rather on essential skills and ideas that are of educational significance. (South Dakota National Science Foundation Systemic Initiative, *South Dakota Mathematics & Science Benchmarks*)

EXIT OUTCOME: An *exit outcome* is a desired behavior a student should demonstrate at a prescribed level of proficiency at the time that student exits the terminal grade of an educational system.

ASSESSMENT: Assessment is a process of observation, conjecture, and constant reformulation of judgments about students' understanding. (National Council of Teachers of Mathematics, *Curriculum and Evaluation Standards for School Mathematics*)

Chapter Two

STANDARD PROCEDURE

In general, ideal K-12 students -- those whose teachers implement the national standards for math, science, and civics and government -- will make use of higher order thinking skills and perceive themselves as members of a global society. What follows is a synthesis of exit outcomes, based on the national standards for math, science, and civics and government.

OUTCOME #1: IDEAL STUDENTS ARE DISCIPLINE AND TECHNOLOGY LITERATE, ABLE TO PARTICIPATE AND COMMUNICATE.

NCTM Curriculum and Evaluation Standards 1-13 (K-12)
National Science Education Standards 2-8 (K-12)
National Standards for Civics and Government I-V (K-12)

OUTCOME #2: IDEAL STUDENTS ARE CREATIVE THINKERS, PROBLEM FORMULATORS, AND PROBLEM SOLVERS.

NCTM Curriculum and Evaluation Standards 1-13 (K-12)
National Science Education Standards 1 (K-12)
National Standards for Civics and Government IV B (K-4)

OUTCOME #3: IDEAL STUDENTS ARE INDEPENDENT AS WELL AS COLLABORATIVE LEARNERS.

NCTM Curriculum and Evaluation Standards 1-13 (K-12)
National Science Education Standards 1-8 (K-12)
National Standards for Civics and Government I A 1 (5-8)

OUTCOME #4: IDEAL STUDENTS ARE EXPERIENCED WITH REAL-LIFE APPLICATIONS.

NCTM Curriculum and Evaluation Standards 1 (K-12), 5 , 8 (5-8),
10 (K-8), 11, 12, 13 (5-8)
6, 7, 9, 10 (9-12)
National Science Education Standards 1 (K-12)
National Standards for Civics and Government IV, V (K-12)

STANDARD PROCEDURE (cont.)

OUTCOME #5: IDEAL STUDENTS ARE HISTORICALLY EQUIPPED.

NCTM Curriculum and Evaluation Standards 13 (9-12)
National Science Education Standards 7 (K-12)
National Standards for Civics and Government I-IV (5-12)

OUTCOME #6: IDEAL STUDENTS ARE IN TUNE WITH THE WORLD AROUND THEM.

NCTM Curriculum and Evaluation Standards 4 (K-12)
National Science Education Standards 5, 6 (K-12)
National Standards for Civics and Government IV (K-12), V (K-4)

OUTCOME #7: IDEAL STUDENTS ARE CONNECTION MAKERS WITHIN AND ACROSS THE DISCIPLINES.

NCTM Curriculum and Evaluation Standards 4 (K-12),
5, 10, 11 (K-4),
5, 6, 12, 13 (5-8),
3, 8, 14 (9-12)
National Science Education Standards 5, 8 (K-12)
National Standards for Civics and Government V (K-12)

OUTCOME #8: IDEAL STUDENTS ARE RISK TAKERS (WITHIN ACADEMIC CONTEXTS) AS WELL AS SELF-MONITORS.

NCTM Curriculum and Evaluation Standards 1, 3, 11 (K-12)
7, 10 (5-12)
12 (5-8)
National Science Education Standards 1 (K-12)

STANDARD PROCEDURE

Following is a description of the author's intent behind each (K-12) exit outcome and a detailed account of how the national standards for the three disciplines fit into this synthesis. *

OUTCOME #1: IDEAL STUDENTS ARE DISCIPLINE AND TECHNOLOGY LITERATE, ABLE TO PARTICIPATE AND COMMUNICATE.

INTENT: ***Students will demonstrate competent use of discipline-specific terminology and available technological resources appropriate to their levels of development, so that they are able to participate in classroom discussions and communicate with peers and teacher their knowledge of the discipline.***

National Council of Teachers of Mathematics *Curriculum and Evaluation Standards for School Mathematics*

Standard 1: Mathematics as Problem Solving (K-4)

In grades K-4, the study of mathematics should allow students to develop and apply strategies to solve a wide variety of problems, verify and interpret results with respect to the original problem, and acquire confidence in using mathematics meaningfully. Calculator use is stressed in problem-solving settings to perform tedious calculations so that students can focus on problem-solving processes rather than on calculations.

Standard 1: Mathematics as Problem Solving (5-8)

In grades 5-8, the mathematics curriculum should include numerous and varied experiences to develop and apply a variety of strategies to solve problems, with emphasis on multistep and nonroutine problems; to verify and interpret results with respect to the original problem situation; and to acquire confidence in using mathematics meaningfully. Students should model many problems concretely, gather and organize data in tables, identify patterns, graph data, use calculators to simplify computations, and use computers to assist in generating and analyzing information.

Standard 1: Mathematics as Problem Solving (9-12)

In grades 9-12, the mathematics curriculum should include the refinement and extension of methods of mathematical problem solving and view problem solving as a process by which the fabric of mathematics is both constructed and reinforced. The use of technology in instruction should alter the learning of mathematics. Students will use calculators and

***Descriptions of correlated student behaviors for each outcome were taken directly or paraphrased from the source documents. Each source is cited prior to the listing of the behaviors.**

computers with appropriate software to investigate, conjecture, and verify their findings.

Standard 2: Mathematics as Communication (K-4)

Communication plays a key role in helping children make important connections among physical, pictorial, graphic, symbolic, verbal, and mental representations of mathematical ideas. Representing, talking, listening, writing, and reading are key communications skills and should be viewed as integral parts of the mathematics curriculum.

Standard 2: Mathematics as Communication (5-8)

Communication in mathematics entails the abilities to read and write mathematics and to interpret and evaluate meanings and ideas. Students will model situations using oral, written, concrete, pictorial, graphical, and algebraic methods. Students will also discuss mathematical ideas, make conjectures and convincing arguments, and appreciate the value of mathematical notation and its role in the development of mathematical ideas.

Standard 2: Mathematics as Communication (9-12)

This standard illustrates the view that in mathematics, problem solving, communication, and reasoning are inextricably connected. In grades 9-12, the mathematics curriculum should include the continued development of language and symbolism to communicate mathematical ideas so that students can reflect on their thinking; formulate mathematical definitions; express discovered generalizations; express mathematical ideas orally and in writing; read written mathematical presentations with understanding; and appreciate the economy, power, and elegance of mathematical notation and its role in the development of mathematical ideas.

Standard 3: Mathematics as Reasoning (K-4)

In grades K-4, the study of mathematics should emphasize reasoning so that students can draw logical conclusions about mathematics, justify their answers and solution processes, and believe that mathematics makes sense.

Standard 3: Mathematics as Reasoning (5-8)

In grades 5-8, reasoning shall permeate the mathematics curriculum so that students can recognize and apply deductive and inductive reasoning, and appreciate the pervasive use and power of reasoning as a part of mathematics.

Standard 3: Mathematics as Reasoning (9-12)

In grades 9-12, the mathematics curriculum should include numerous and

varied experiences that reinforce and extend logical reasoning skills so that all students can follow logical arguments and construct simple valid arguments.

Standard 4: Mathematical Connections (K-4)

In grades K-4, the study of mathematics should include opportunities to make connections so that students can link conceptual and procedural knowledge.

Standard 4: Mathematical Connections (5-8)

In grades 5-8, the mathematics curriculum should include the investigation of mathematical connections so that students can explore problems and describe results using graphical, numerical, physical, algebraic, and verbal mathematical models or representations, and value the role of mathematics in our culture and society.

Standard 4: Mathematical Connections (9-12)

In grades 9-12, the mathematics curriculum should include investigation of the connections and interplay among various mathematical topics and their applications so that all students can recognize equivalent representations of the same concept.

Standard 5: Estimation (K-4)

In grades K-4, the curriculum should include estimation so students can recognize when an estimate is appropriate and determine the reasonableness of results.

Standard 5: Number and Number Relationships (5-8)

In grades 5-8, the mathematics curriculum should include the continued development of number and number relationships so that students can understand, represent, and use numbers in a variety of equivalent forms (integer, fraction, decimal, percent, exponential, and scientific notation) and understand and apply ratios, proportions, and percents in a wide variety of situations.

Standard 5: Algebra (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of algebraic concepts and methods so that all students can represent situations that involve variable quantities with expressions, equations, inequalities, and matrices; use tables and graphs as tools to interpret expressions, equations, and inequalities; and appreciate the power of mathematical abstraction and symbolism.

Standard 6: Number Sense (K-4)

In grades K-4, the mathematics curriculum should include whole number concepts and skills so that students can understand our numeration system by relating, counting, grouping, and place-value concepts.

Standard 6: Number Systems and Number Theory (5-8)

In grades 5-8, the mathematics curriculum should include the study of number systems and number theory so that students can understand and appreciate the need for numbers beyond the whole numbers; develop and use order relations for whole numbers, fractions, decimals, integers, and rational numbers; and extend their understanding of whole number operations to fractions, decimals, integers, and rational numbers.

Standard 6: Functions (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of functions so that all students can represent and analyze relationships using tables, verbal rules, equations, and graphs; translate among tabular, symbolic, and graphical representations of functions; analyze the effects of parameter changes on the graphs of functions; and [on the college-bound level] understand operations on, and the general properties and behavior of, classes of functions.

Standard 7: Concepts of Whole Number Operations

In grades K-4, the mathematics curriculum should include concepts of addition, subtraction, multiplication, and division of whole numbers so that students can develop operation sense and relate the mathematical language and symbolism of operations to various problem situations and informal language.

Standard 7: Computation and Estimation (5-8)

In grades 5-8, the mathematics curriculum should develop the concepts underlying computation and estimation in various contexts so that students can compute with whole numbers, fractions, decimals, integers, and rational numbers; develop, analyze, and explain procedures for computation and techniques for estimation; and use estimation to check the reasonableness of results.

Standard 7: Geometry from a Synthetic Perspective (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of the geometry of two and three dimensions so that all students can interpret and draw three-dimensional objects; classify figures in terms of congruence and similarity and apply these relationships; deduce properties of, and relationships between, figures from given assumptions; and [for college-bound students] develop an understanding of an

axiomatic system through investigating and comparing various geometries.

Standard 8: Whole Number Computation (K-4)

In grades K-4, the mathematics curriculum should develop whole number computation so that students can model, explain, and develop reasonable proficiency with basic facts and algorithms; use a variety of mental computation and estimation techniques; use calculators in appropriate computational situations; and select and use computation techniques appropriate to specific problems and determine whether the results are reasonable.

Standard 8: Patterns and Functions (5-8)

In grades 5-8, the mathematics curriculum should include explorations of patterns and functions so that students can describe, extend, analyze and create a wide variety of patterns; describe and represent relationships with tables, graphs, and rules; and analyze functional relationships to explain how a change in one quantity results in a change in another.

Standard 8: Geometry from an Algebraic Perspective (9-12)

In grades 9-12, the mathematics curriculum should include the study of the geometry of two and three dimensions from an algebraic point of view so that all students can translate between synthetic and coordinate representations; deduce properties of figures using transformations and using coordinates; identify congruent and similar figures using transformations; analyze properties of Euclidean transformation and relate translations to vectors; and [for college-bound students] deduce properties of figures using vectors.

Standard 9: Geometry and Spatial Sense (K-4)

In grades K-4, the mathematics curriculum should include two- and three-dimensional geometry so that students can describe, model, draw, and classify shapes; develop spatial sense; and recognize and appreciate geometry in their world.

Standard 9: Algebra (5-8)

In grades 5-8, the mathematics curriculum should include explorations of algebraic concepts and processes so that students can understand the concepts of variable, expression, and equation; represent situations and number patterns with tables, graphs, verbal rules, and equations and explore the interrelationships of these representations; analyze tables and graphs to identify properties and relationships; develop confidence in solving linear equations using concrete, informal, and formal methods; and investigate inequalities and nonlinear equations informally.

Standard 9: Trigonometry (9-12)

In grades 9-12, the mathematics curriculum should include the study of trigonometry so that students can use appropriate technology to apply trigonometry to problem situations involving triangles and [for college-bound students] apply general graphing techniques to trigonometric functions.

Standard 10: Measurement (K-4)

In grades K-4, the mathematics curriculum should include measurement so that students can understand the attributes of length, capacity, weight, mass, area, volume, time, temperature, and angle; and make and use estimates of measurement.

Standard 10: Statistics (5-8)

In grades 5-8, the mathematics curriculum should include exploration of statistics in real-world situations so that students can systematically collect, organize, and describe data; construct, read, and interpret tables, charts, and graphs, and develop an appreciation for statistical methods as powerful means for decision making.

Standard 10: Statistics (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of data analysis and statistics so that all students can construct and draw inferences from charts, tables, and graphs that summarize data from real-world situations; and understand and apply measures of central tendency, variability, and correlation.

Standard 11: Statistics and Probability (K-4)

In grades K-4, the mathematics curriculum should include experiences with data analysis and probability so that students can collect, organize, and describe data; construct, read, and interpret displays of data; and explore concepts of chance.

Standard 11: Probability (5-8)

In grades 5-8, the mathematics curriculum should include explorations of probability in real-world situations so that students can model situations by devising and carrying out experiments or simulations to determine probabilities; model situations by constructing a sample space to determine probabilities; and develop an appreciation for the pervasive use of probability in the real world.

Standard 11: Probability (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of probability so that all students can use simulations to estimate

probabilities, understand the concept of a random variable, and describe the normal curve and use its properties to answer questions about sets of data that are assumed to be normally distributed.

Standard 12: Fractions and Decimals (K-4)

In grades K-4, the mathematics curriculum should include fractions and decimals so that students can develop concepts of fractions, mixed numbers, and decimals; develop number sense from fractions and decimals; use models to relate fractions to decimals and to find equivalent fractions; and use models to explore operations on fractions and decimals.

Standard 12: Geometry (5-8)

In grades 5-8, the mathematics curriculum should include the study of the geometry of one, two, and three dimensions in a variety of situations so that students can identify, describe, compare, and classify geometric figures; visualize and represent geometric figures with special attention to developing spatial sense; explore transformations of geometric figures; understand and apply geometric properties and relationships; and develop an appreciation of geometry as a means of describing the physical world.

Standard 12: Discrete Mathematics (9-12)

In grades 9-12, the mathematics curriculum should include topics from discrete mathematics so that all students can represent problem situations using discrete structures such as finite graphs, matrices, sequences, and recurrence relations; represent and analyze finite graphs using matrices; and [for college-bound students] investigate problem situations that arise in connection with computer validation and the application of algorithms.

Standard 13: Patterns and Relationships (K-4)

In grades K-4, the mathematics curriculum should include the study of patterns and relationships so that students can recognize, describe, extend, and create a wide variety of patterns; represent and describe mathematical relationships; and explore the use of variables and open sentences to express relationships.

Standard 13: Measurement (5-8)

In grades 5-8, the mathematics curriculum should include extensive concrete experiences using measurement so that students can extend their understanding of the process of measurement; estimate, make, and use measurements to describe and compare phenomena; select appropriate units and tools to measure to the degree of accuracy required in a particular situation; understand the structure and use of systems of measurement; extend their understanding of the concepts of perimeter, area, volume, angle measure, capacity, and weight and mass; and

develop the concepts of rates and other derived and indirect measurements.

Standard 13: Conceptual Underpinnings of Calculus (9-12)

In grades 9-12, the mathematics curriculum should include the informal exploration of calculus concepts from both a graphical and numerical perspective so that all students can investigate limiting processes by examining infinite sequences and series and areas under curves; and [for college-bound students] understand the conceptual foundations of limit, the area under a curve, the rate of change, and the slope of a tangent line, and their applications in other disciplines; and analyze the graphs of polynomial, rational, radical, and transcendental functions.

National Committee on Science Education Standards and Assessment,
National Science Education Standards

Standard 2: Physical Science (K-4)

As a result of activities in grades K-4, all students should develop an understanding of properties of objects and materials, position and motion of objects, and forms of energy -- heat, light, electricity, and magnetism.

Standard 2: Physical Science (5-8)

As a result of activities in grades 5-8, all students should develop an understanding of properties of matter, the particulate model of matter, motions and changes in motions, and transformations of energy.

Standard 2: Physical Science (9-12)

As a result of activities in grades 9-12, all students should develop an understanding of the atomic structure of matter, chemical interactions and transformations, forces and motion, conservation of energy, and interactions of energy and matter.

Standard 3: Life Science (K-4)

As a result of their activities in grades K-4, all students should develop an understanding of characteristics of organisms, life cycles of organisms, and organisms and environments.

Standard 3: Life Science (5-8)

As a result of their activities in grades 5-8, all students should develop an understanding of structure and function in living systems, reproduction and heredity, populations and ecosystems, and diversity and adaptations of organisms.

Standard 3: Life Science (9-12)

As a result of their activities in grades 9-12, all students should develop an understanding of the diversity of organisms, the cell, heredity, matter, energy, and organization of living systems, evolution of living systems, and biosphere and interdependence.

Standard 4: Earth and Space Science (K-4)

As a result of their activities in grades K-4, all students should develop an understanding of properties of earth materials and objects in the sky.

Standard 4: Earth and Space Science (5-8)

As a result of their activities in grades 5-8, all students should develop an understanding of the structure of the Earth system, Earth's history, and Earth in the Solar System.

Standard 4: Earth and Space Science (9-12)

As a result of their activities in grades 9-12, all students should develop an understanding of forces and energy in the Earth system, geochemical processes and cycles in the Earth system, and the Earth in the Universe.

Standard 5: Science and Technology (K-4)

As a result of activities in grades K-4, all students should develop the ability to state a problem, design and implement a solution, evaluate the solution, and communicate the problem, design, and solution.

Standard 5: Science and Technology (5-8)

As a result of activities in grades 5-8, all students should develop the following abilities and understandings: the process of technological design, connections between science and technology, and the similarities and differences between scientific inquiry and technological design.

Standard 5: Science and Technology (9-12)

As a result of activities in grades 9-12, all students should develop the following understandings: the nature of technology, the process of technological design, the interactions between science and technology, and the similarities and differences between science and technology.

Standard 6: Science and Societal Changes (K-4)

As a result of activities in grades K-4, all students should develop an understanding of the characteristics and needs of populations, types of resources, changes in environments, and personal actions.

Standard 6: Science and Societal Changes (5-8)

As a result of activities in grades 5-8, all students should develop an

understanding of populations, resources, and environments in societies; natural hazards; technology and society; risks and benefits; and personal decision making.

Standard 6: Science and Societal Changes (9-12)

As a result of activities in grades 9-12, all students should develop an understanding of population growth, natural resources, environmental degradation, natural and human-induced hazards, community health, global changes, and science, technology, and public policy.

Standard 7: History and Nature of Science (K-4)

As a result of activities in grades K-4, all students should develop an understanding of scientific inquiry and science as a human endeavor.

Standard 7: History and Nature of Science (5-8)

As a result of activities in grades 5-8, all students should develop an understanding of scientific inquiry, science as a human endeavor, and science and society.

Standard 7: History and Nature of Science (9-12)

As a result of activities in grades 9-12, all students should develop an understanding of scientific inquiry, scientific explanations, nature of scientific knowledge, and transformations in science.

Standard 8: Unifying Concepts and Processes (K-12)

All students (K-12) should develop an understanding of and ability to use the following concepts and processes: systems, organization, form and function, interactions, change, measurement, models, scale, diversity, adaptation and evolution, and explanation.

Center for Civic Education, *National Standards for Civics and Government*

Standard I: What Is Government and What Should It Do? (K-4)

Students should be able to provide a simple description of government. Students should be able to explain the difference between authority and power without authority and the idea that authority comes from the consent of the governed. Students should be able to explain why government is necessary in their classroom, school, community, state, and nation. Students should be able to explain the purposes of rules and laws and why they are important in their classroom, school, community, state, and nation. Students should be able to explain the basic differences between limited and unlimited governments. Students should be able to give reasons for limiting the powers of government.

Standard I: What Is Government and What Should It Do? (5-8)

Students should be able to evaluate the implications for individuals and society of competing ideas regarding the purposes of government. Students should be able to explain the importance of the rule of law for the protection of individual rights and the common good. Students should be able to explain the essential characteristics of limited and unlimited government and explain the importance of limited government to individual freedom. Students should be able to explain different uses of the term *constitution* and to distinguish between the mere existence of a constitution and a constitutional government. Students should be able to explain the various purposes constitutions serve. Students should be able to explain those conditions which are essential for the flourishing of constitutional government. Students should be able to explain the advantages and disadvantages of federal, confederate, and unitary systems of government. Students should be able to explain the major characteristics of systems of shared powers and of parliamentary systems.

Standard I: What Is Government and What Should It Do? (9-12)

Students should be able to evaluate, take, and defend positions on competing ideas regarding the purposes of government. Students should be able to evaluate, take, and defend positions on the importance of the rule of law and on the sources, purposes, and functions of law. Students should be able to explain the essential characteristics of limited and unlimited governments and evaluate their implications for individual rights and the common good. Students should be able to evaluate, take, and defend the proposition that in a free society there must be independent associations to mediate between individuals and government. Students should be able to evaluate, take, and defend positions on competing ideas regarding relations among political and economic freedoms. Students should be able to explain different uses of the term *constitution* and to distinguish between governments with a constitution and a constitutional government. Students should be able to explain the various purposes constitutions serve. Students should be able to evaluate, take, and defend positions on what conditions are essential for the flourishing of constitutional government. Students should be able to evaluate, take, and defend positions regarding the relative merits of federal, confederate, and unitary systems of government. Students should be able to evaluate, take, and defend positions regarding the relative merits of systems of shared powers, presidential and parliamentary systems.

Standard II: What are the Basic Values, Principles, and Ideals of American Democracy? (K-4)

Students should be able to describe the essential characteristics of the

United States Constitution and their state constitution. Students should be able to explain the importance of the United States Constitution and their state constitution. Students should be able to explain the importance of the fundamental values and principles of American democracy. Students should be able to identify some important beliefs Americans have about themselves and about their government. Students should be able to describe diversity in the United States and identify its benefits and costs. Students should be able to describe conflicts that arise over diversity and identify and evaluate ways conflicts can be prevented and managed. Students should be able to explain the importance of Americans sharing and supporting certain values, principles, and beliefs. Students should be able to describe conflicts that sometimes arise between values and principles and evaluate, take, and defend positions on those conflicts. Students should be able to identify ways people can work together to further the ideals of American democracy.

Standard II: What Are the Foundations of the American Political System? (5-8)
Students should be able to explain the fundamental ideas of American constitutional government and their importance for the protection of individual rights and the common good. Students should be able to explain the meaning and importance of the fundamental values and principles of American constitutional democracy. Students should be able to evaluate, take, and defend positions on issues in which fundamental values and principles are in conflict. Students should be able to evaluate, take, and defend positions on issues concerning ways and means to reduce disparities between American ideals and realities. Students should be able to identify some of the most common attitudes and beliefs of Americans toward society, politics, and government. Students should be able to evaluate, take, and defend positions on the value and challenges of diversity in American life. Students should be able to explain the importance of shared political values and principles to American society. Students should be able to explain how certain dispositions or traits of character may enhance their effectiveness in participating in our constitutional democracy and in promoting healthy functioning.

Standard II: What Are the Foundations of the American Political System? (9-12)
Students should be able to evaluate, take, and defend positions on which ideas of American constitutional government are most important. Students should be able to evaluate, take, and defend positions concerning the extent to which Americans have internalized the values and principles of the Constitution and as a result have demanded that its ideals be made realities. Students should be able to evaluate, take, and defend positions on which characteristics make American society

distinctive. Students should be able to evaluate, take, and defend positions on the importance of voluntarism in American society. Students should be able to evaluate, take, and defend positions about the contemporary role of interest groups, religious, charitable, service, and civic groups in American social and political life. Students should be able to evaluate, take, and defend positions on the value and challenges of diversity in American life both historically and at present. Students should be able to explain the importance of shared political and civic beliefs and values to the maintenance of constitutional democracy in an increasingly diverse American society. Students should be able to describe the character of American political conflict and explain the factors that usually tend to prevent or lower its intensity. Students should be able to evaluate, take, and defend positions on what the fundamental values and principles of American constitutional democracy are, which are in conflict, and what their importance is to the maintenance of constitutional democracy. Students should be able to evaluate, take, and defend positions on issues concerning the disparities between American ideals and realities. Students should be able to evaluate, take, and defend positions on the dispositions that lead individuals to become independent members of society and explain why those dispositions are important to American democracy. Students should be able to evaluate, take, and defend positions on the dispositions that foster respect for individual rights and explain why they are important to American constitutional democracy. Students should be able to evaluate, take, and defend positions on the traits that incline citizens to public affairs and explain, using historical and contemporary examples, why they are important to the preservation and improvement of American constitutional democracy. Students should be able to evaluate, take, and defend positions on dispositions that facilitate thoughtful and effective participation in public affairs and explain why they are important to the preservation and improvement of American constitutional democracy.

Standard III: How Does the Government Established by the Constitution Embody the Purposes and Principles of American Democracy? (K-4)

Students should be able to explain the basic organization of the national government. Students should be able to explain the major ways to limit the powers of the national government and their importance. Students should be able to give examples of ways the national government protects individual rights and promotes the common good. Students should be able to explain the most important responsibilities their state constitutions give to their state governments. Students should be able to explain the most important responsibilities of their local government. Students should be able to identify the members of the legislative branches and the heads of the executive branches of their local, state, and national governments.

Standard III: How Does the Government Established by the Constitution Embody the Principles and Purposes of American Democracy? (5-8)

Students should be able to explain how the U.S. Constitution delegates power to the institutions of the national government. Students should be able to explain why the Constitution provides for the sharing of power within the national government. Students should be able to explain how the Constitution organizes the powers of the national government in order to prevent their abuse. Students should be able to explain the essential elements of the American federal system and why the Framers adopted this system in which the powers of government are shared by the national and state governments. Students should be able to identify several important domestic and foreign policies of the national government and explain how they may affect their daily lives, protect individual rights, and promote the common good. Students should be able to explain the constitutional basis of the government's authority to levy taxes, the necessity of taxes and the purposes for which taxes are used. Students should be able to explain why states have their own constitutions and the relationship of state constitutions to the federal constitution. Students should be able to describe the organization and major responsibilities of state and local governments. Students should be able to explain the importance of the rule of law in the American political system. Students should be able to explain and evaluate how law is used to protect individual rights and promote the common good and manage conflicts in American society. Students should be able to explain how political parties, campaigns, and elections provide opportunities for citizens to participate in the political process. Students should be able to explain how interest groups, unions, professional organizations, religious, charitable, service, and civic groups provide opportunities for individuals to participate in the political process. Students should be able to explain how they can acquire and evaluate information about public issues. Students should be able to explain how public policy is formed and carried out and what roles citizens can play in the process.

Standard III: How Does the Government Established by the Constitution Embody the Principles and Purposes of American Democracy? (9-12)

Students should be able to explain how the U.S. Constitution delegates power to government and seeks to prevent the abuse of power. Students should be able to evaluate, take, and defend positions on issues concerning how the federal system should operate and on the interpretation and application of the principles and purposes of federalism. Students should be able to evaluate, take, and defend positions on issues concerning the purposes, organization, and functions of the institutions of the national government and on what matters should be the responsibility of the national, state, or local government. Students should be able to evaluate, take, and defend positions on services and benefits government ought to

provide and how they should be financed. Students should be able to evaluate, take, and defend positions on the roles and responsibilities of state and local governments and their relationship to the national government and on issues regarding the structure of role of state and local government. Students should be able to evaluate, take, and defend positions on issues regarding the responsibilities of state and local governments. Students should be able to evaluate, take, and defend positions on the role and importance of law in the American political system. Students should be able to evaluate, take, and defend positions on the uses of law to achieve the purposes of American constitutional democracy. Students should be able to evaluate, take, and defend positions on current issues regarding judicial protection of individual rights. Students should be able to evaluate, take, and defend positions on how the public agenda is set and the role of public opinion in American politics. Students should be able to evaluate, take, and defend positions on the character and roles of political parties, campaigns, elections, interest groups, and television in American politics. Students should be able to evaluate, take, and defend positions on the formation and implementation of public policy.

Standard IV: What Is the Relationship of the United States to other Nations and to World Affairs? (K-4)

Students should be able to explain that the world is divided into different nations which interact with each other. Students should be able to explain the major ways nations interact with one another. Students should be able to explain some of the important ways in which Americas and other peoples have influenced one another. Students should be able to explain how and why events throughout the world have important effects on their own lives and on their community, state, and nation.

Standard IV: What Is the Relationship of American Politics and Government to World Affairs? (5-8)

Students should be able to explain how the world is organized politically. Students should be able to explain how nation-states interact with each other. Students should be able to explain how United States foreign policy is made and the means by which it is carried out. Students should be able to explain the role of major international organizations in the world today. Students should be able to describe the influence of American political ideas on other nations. Students should be able to evaluate proposals for dealing with significant political, demographic, and environmental developments in the world.

Standard IV: What Is the Relationship of American Politics and Government to World Affairs? (9-12)

Students should be able to explain how the world is organized politically

and how nation-states interact with each other. Students should be able to evaluate, take, and defend positions on the purposes and functions of international organizations in the world today.
Students should be able to explain the principle foreign policy positions the United States has taken and evaluate their consequences. Students should be able to explain how United States foreign policy is made and the means by which it is carried out. Students should be able to evaluate foreign policy positions in light of national interest and American values and principles. Students should be able to evaluate, take, and defend positions on the impact of American political ideas on the world. Students should be able to evaluate, take, and defend positions on the effects of significant political, economic, technological, and cultural developments on the United States and other nations. Students should be able to evaluate, take, and defend positions on what the response of American governments at all levels should be to world demographic and environmental developments. Students should be able to evaluate, take, and defend positions on what the relationship of the United States should be to international organizations.

Standard V: What Are the Roles of the Citizen in American Democracy? (K-4)
Students should be able to explain the meaning of citizenship in the United States and how one becomes a citizen of the United States. Students should be able to explain why personal rights, political rights, and economic rights are important to the individual and to a democratic society. Students should be able to explain the importance of individuals assuming their personal and public responsibilities in order for American democracy to flourish. Students should be able to explain how participating in public life may help Americans attain their individual and community goals. Students should be able to describe the means by which citizens can influence the decisions and actions of their government. Students should be able to explain and apply criteria useful in evaluating rules and laws. Students should be able to explain the importance of political leadership and public service in their school, community, state, and nation. Students should be able to explain and apply criteria useful in selecting political leaders.

Standard V: What Are the Roles of the Citizen in the American Political System? (5-8)
Students should be able to explain the meaning of citizenship in the United States and how one becomes a United States citizen. Students should be able to evaluate, take, and defend positions on issues involving personal, political, and economic rights. Students should be able to explain the importance of citizens fulfilling their personal and public responsibilities in order for constitutional democracy to flourish. Students should be able to explain the relationship between participating

in public life and the attainment of individual and public goals. Students should be able to describe the means by which citizens may monitor and influence the formation and implementation of public policy. Students should be able to explain the importance of political leadership and public service in a constitutional democracy.

Standard V: What Are the Roles of the Citizen in the American Political System? (9-12)
Students should be able to evaluate, take, and defend positions on the meaning of American citizenship and be able to explain how one becomes a citizen of the United States. Students should be able to evaluate, take, and defend positions on issues involving personal, political, and economic rights. Students should be able to evaluate, take, and defend positions on the relationships among personal, political, and economic rights. Students should be able to evaluate, take, and defend positions on the importance of citizens assuming personal responsibilities in order for constitutional democracy to flourish. Students should be able to evaluate, take, and defend positions on the idea that it is a responsibility of citizens to reexamine and reflect on basic constitutional principles. Students should be able to evaluate, take, and defend positions on the relationship between politics and the attainment of individual and public goals. Students should be able to explain the difference between political and social participation. Students should be able to evaluate, take, and defend positions on the means which citizens should use to monitor and influence the formation and implementation of public policy. Students should be able to evaluate, take, and defend positions on the functions of leadership in a constitutional democracy. Students should be able to explain the importance of knowledge to competent and responsible participation in American constitutional democracy.

OUTCOME #2: IDEAL STUDENTS ARE CREATIVE THINKERS, PROBLEM FORMULATORS, AND PROBLEM SOLVERS.

INTENT: ***Students will model creative thinking processes when given tasks to complete or problems to solve. Given basic equations or data sets, students will invent real-life problems, present them verbally, graphically, or in written form, and suggest solutions based upon their thought processes. In so doing, they will apply the factual information from the specific disciplines in thoughtful and meaningful ways.***

National Council of Teachers of Mathematics ***Curriculum and Evaluation Standards for School Mathematics:***

Standard 1: Mathematics as Problem Solving (K-4)
In grades K-4, the study of mathematics should emphasize problem

solving so that students can use problem-solving approaches to investigate and understand mathematical content and formulate problems from everyday mathematical situations.

Standard 1: Mathematics as Problem Solving (5-8)

In grades 5-8, the mathematics curriculum should include numerous and varied experiences with problem solving as a method of inquiry and application so that students can use problem-solving approaches to investigate and understand mathematical content and formulate problems form situations within and outside mathematics.

Standard 1: Mathematics as Problem Solving (9-12)

In grades 9-12, the mathematics curriculum should include the refinement and extension of methods of mathematical problem solving so that all students can use, with increasing confidence, problem-solving approaches to investigate and understand mathematical content, apply integrated mathematical problem-solving strategies to solve problems from within and outside mathematics, and recognize and formulate problems from situations within and outside mathematics.

Standard 2: Mathematics as Communication (K-4)

This standard highlights the need to involve children in actively doing mathematics. Exploring, investigating, describing, and explaining mathematical ideas promote communication. Teachers facilitate this process when they pose probing questions and invite children to explain their thinking. Teachers also can assess students' knowledge and insight by listening and observing. Meaningful learning is necessary if mathematics is to make sense and if communication is to be possible.

Standard 2: Mathematics as Communication (5-8)

The ability to read, listen, think creatively, and communicate about problem situations, mathematical representations, and the validation of solutions will help students to develop and deepen their understand of mathematics.

Standard 2: Mathematics as Communication (9-12)

In grades 9-12, the mathematics curriculum should include the continued development of language and symbolism to communicate mathematical ideas keeping in mind that problem solving, communication, and reasoning are inextricably connected.

Standard 3: Mathematics as Reasoning (K-4)

In grades K-4, the study of mathematics should emphasize reasoning so that students can use models, known facts, properties, and relationships to

explain their thinking and use patterns and relationships to analyze mathematical situations.

Standard 3: Mathematics as Reasoning (5-8)

In grades 5-8, reasoning shall permeate the mathematics curriculum so that students can make and evaluate mathematical conjectures and arguments and validate their own thinking.

Standard 3: Mathematics as Reasoning (9-12)

In grades 9-12, the mathematics curriculum should include numerous and varied experiences that reinforce and extend logical reasoning skills so that all students can formulate counterexamples, and so that, in addition, college-bound students can construct proofs for mathematical assertions, including indirect proofs and proofs by mathematical induction.

Standard 4: Mathematical Connections (K-4)

When children enter school, they have not segregated their learning into separate school subjects of topics within an academic area. Thus, it is particularly important to build on the wholeness of their perspective of the world and expand it to include more of the world of mathematics. This can be done in many ways, both within and outside the realm of mathematics. All too often, children come to believe that mathematics is an academic exercise that occurs only in schools, whereas solving problems outside of school is different. Students need to see when and how mathematics can be used, rather than be promised that someday they will use it.

Standard 4: Mathematical Connections (5-8)

Varied problem settings are a means by which students can highlight and build mathematical connections. The creative aspect of making sense of mathematics is a real confidence builder. "Connected" mathematics should not be disconnected from students' daily lives.

Standard 4: Mathematical Connections (9-12)

This standard emphasizes the importance of the connections among mathematical topics and those between mathematics and other disciplines. Two general types of connections are important: modeling connections between problem situations that may arise in the real world or in disciplines other than mathematics and their mathematical representation(s); and mathematical connections between two equivalent representations and between corresponding processes in each.

Standard 5: Estimation (K-4)

In grades K-4, the curriculum should include estimation so students can

explore estimation strategies and apply estimation in working with quantities, measurement, computation, and problem solving.

Standard 5: Number and Number Relationships (5-8)

In grades 5-8, the mathematics curriculum should include the continued development of number and number relationships so that students can develop number sense for whole numbers, fractions, decimals, integers, and rational numbers, and investigate relationships among fractions, decimals, and percents.

Standard 5: Algebra (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of algebraic concepts and methods so that all students can operate on expressions and matrices, and solve equations and inequalities and use matrices to solve linear systems.

Standard 6: Number Sense and Numeration (K-4)

In grades K-4, the mathematics curriculum should include whole number concepts and skills so that students can develop number sense. Number sense includes five components: developing number meanings, exploring number relationships with manipulatives, understanding relative magnitudes of numbers, developing intuitions about the relative effect of operating on numbers, and developing referents for measures of common objects and situations.

Standard 6: Number Systems and Number Theory (5-8)

In grades 5-8, the mathematics curriculum should include the study of number systems and number theory so that students can develop and apply number theory concepts in real-world and mathematical problem situations.

Standard 6: Functions (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of functions so that all students can recognize that a variety of problem situations can be modeled by the same type of function.

Standard 7: Concepts of Whole Number Operations (K-4)

In grades K-4, the mathematics curriculum should include concepts of addition, subtraction, multiplication, and division of whole numbers so that students can develop meaning for the operations by modeling and discussing a rich variety of problem situations.

Standard 7: Computation and Estimation (5-8)

In grades 5-8, the mathematics curriculum should develop the concepts

underlying computation and estimation in various contexts so that students can use computation, estimation, and proportions to solve problems and use estimation to check the reasonableness of results.

Standard 7: Geometry from a Synthetic Perspective (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of the geometry of two and three dimensions so that all students can represent problem situations with geometric models and apply properties of figures.

Standard 8: Whole Number Computation (K-4)

The purpose of computation is to solve problems. Our technological age requires that students rethink how computation is done today. An awareness that computation is learned and used to attain some goal develops when problem situations and computations are explicitly linked throughout all aspects of work with computations.

Standard 8: Patterns and Functions (5-8)

In grades 5-8, the mathematics curriculum should include exploration of patterns and functions so that students can use patterns and functions to represent and solve problems.

Standard 8: Geometry from an Algebraic Perspective (9-12)

In grades 9-12, the mathematics curriculum should include the study of the geometry of two and three dimensions from an algebraic point of view so that college-bound students can apply transformation, coordinates, and vectors in problem solving.

Standard 9: Geometry and Spatial Sense (K-4)

In grades K-4, the mathematics curriculum should include two- and three-dimensional geometry so that students can investigate and predict the results of combining, subdividing, and changing shapes and relate geometric ideas to number and measurement ideas.

Standard 9: Algebra (5-8)

In grades 5-8, the mathematics curriculum should include explorations of algebraic concepts and processes so that students can apply algebraic methods to solve a variety of real-world and mathematical problems.

Standard 9: Trigonometry (9-12)

In grades 9-12, the mathematics curriculum should include the study of trigonometry so that all students can apply trigonometry to problem situations involving triangles.

Standard 10: Measurement (K-4)

In grades K-4, the mathematics curriculum should include measurement so that students can make and use measurements in problem and everyday situations.

Standard 10: Statistics (5-8)

In grades 5-8, the mathematics curriculum should include exploration of statistics in real-world situations so that students can make inferences and convincing arguments that are based on data analysis and evaluate arguments that are based on data analysis.

Standard 10: Statistics (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of data analysis and statistics so that all students can design a statistical experiment to study a problem, conduct the experiment, and interpret and communicate the outcomes.

Standard 11: Statistics and Probability (K-4)

In grades K-4, the mathematics curriculum should include experiences with data analysis and probability so that students can formulate and solve problems that involve collecting and analyzing data.

Standard 11: Probability (5-8)

In grades 5-8, the mathematics curriculum should include explorations of probability in real-world situations so that students can appreciate the power of using a probability model by comparing experimental results with mathematical expectations and make predictions that are based on experimental or theoretical probabilities.

Standard 11: Probability (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of probability so that all students can use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty, create and interpret discrete probability distributions, and [for the college-bound student] apply the concept of a random variable to generate and interpret probability distributions including binomial, uniform, normal, and chi square.

Standard 12: Fractions and Decimals (K-4)

In grades K-4, the mathematics curriculum should include fractions and decimals so that students can apply fractions and decimals to problem situations.

Standard 12: Geometry (5-8)

In grades 5-8, the mathematics curriculum should include the study of the geometry of one, two, and three dimensions in a variety of situations so that students can represent and solve problems using geometric models.

Standard 12: Discrete Mathematics (9-12)

In grades 9-12, the mathematics curriculum should include topics from discrete mathematics so that all students can develop and analyze algorithms, solve enumeration and finite probability problems, and [for college-bound students] represent and solve problems using linear programming and difference equations.

Standard 13: Patterns and Relationships (K-4)

From the earliest grades, the curriculum should give students opportunities to focus on regularities in events, shapes, designs, and sets of numbers. Children should begin to see that regularity is the essence of mathematics. Children should be encouraged to explore, explain, and invent patterns.

Standard 13: Measurement (5-8)

In grades 5-8, the mathematics curriculum should include extensive concrete experiences using measurement so that students can develop formulas and procedures for determining measures to solve problems.

Standard 13: Conceptual Underpinnings of Calculus (9-12)

In grades 9-12, the mathematics curriculum should include the informal exploration of calculus concepts from both a graphical and a numerical perspective so that all students can determine maximum and minimum points of a graph and interpret the results in problem situations.

National Committee on Science Education Standards and Assessment,
National Science Education Standards

Standard 1: Science as Inquiry (K-4)

As a result of inquiry-oriented activities in grade K-4, all students should develop the ability to ask for information to use in answering a question; plan and conduct a simple investigation; employ simple equipment and experiences to gather data and extend the senses; use data and experiences to construct a reasonable explanation; and communicate about investigations and explanations.

Standard 1: Science as Inquiry (5-8)

As a result of inquiry-oriented activities in grades 5-8, all students should develop the ability to identify appropriate questions for a scientific

investigation; design and conduct a scientific investigation; use appropriate tools and technologies to gather, analyze, and interpret data; construct explanations and models using evidence; think critically and logically about the relationships between evidence and explanations; recognize and analyze alternative explanations and procedures; and communicate scientific procedures and explanations.

Standard 1: Science as Inquiry (9-12)

As a result of inquiry-oriented activities in grades 9-12, all students should develop the ability to identify the questions and concepts that guide scientific investigations; design and conduct a full scientific investigation; use technologies to improve investigations and communications; construct and revise scientific explanations and models using logic and evidence; recognize and analyze alternative explanations and models; communicate and defend a scientific argument; and analyze a historical or contemporary scientific inquiry.

Center for Civic Education, *National Standards for Civics and Government*

Standard IV, B: How Do Nations Interact with Each Other? (K-4)

To achieve this standard, students should be able to identify ways in which nations try to resolve issues peacefully and explain why it is important that nations try to resolve issues peacefully.

OUTCOME #3: IDEAL STUDENTS ARE INDEPENDENT AS WELL AS COLLABORATIVE LEARNERS.

INTENT: ***Students will demonstrate the skills necessary to complete tasks, projects, and presentations independent of outside help, as well as in collaborative environments with their peers.***

National Council of Teachers of Mathematics *Curriculum and Evaluation Standards for School Mathematics*

Standard 1: Mathematics as Problem Solving (K-12)

Problem solving is not a distinct topic but a process that should permeate the entire program and provide the context in which concepts and skills can be learned. Students should learn to value the process of solving problems independently or collaboratively as much as they value the solutions. In the early years of the educational program, most problem situations will arise from school and other everyday experiences. When mathematics evolves naturally from problem situations that have meaning to the learners and are regularly related to their environment, it becomes relevant and helps those learners link their knowledge to many kinds of situations. When problem solving becomes an integral part of classroom

instruction and children experience success in solving problems on the independent and collaborative levels, they gain confidence in doing mathematics and develop persevering and inquiring minds. They also grow in their ability to communicate mathematically and use higher-level thinking processes. Experiences designed to foster continued intellectual curiosity and increasing independence should encourage students to become self-directed learners who routinely engage in constructing, symbolizing, applying, and generalizing mathematical ideas. Such experiences are essential in order for students to develop the capability for their own lifelong learning and to internalize the view that mathematics is a process, a body of knowledge, and a human creation.

Standard 2: Mathematics as Communication (K-12)

Communication plays a key role in helping children make important connections among physical, pictorial, graphic, symbolic, verbal, and mental representations of mathematical ideas. It is important, therefore, to provide children with opportunities to "talk mathematics." Communicating by talking and listening is also very important. When groups of children discuss and solve problems, they are able to connect the language they know with mathematical terms that might be unfamiliar to them. The make sense of those problems. The use of concrete materials is particularly appropriate because they give the children an initial basis for conversation. Such occasions also permit the teacher to observe individual students, to ask probing questions, and to note or attend to any conceptual difficulties individual students may be experiencing.

Standard 3: Mathematics as Reasoning (K-12)

Children should be encouraged to justify their solutions, thinking processes, and conjectures in a variety of ways. Manipulatives and other physical models help children relate processes to their conceptual underpinnings and give them concrete objects to talk about in explaining and justifying their thinking. Observing children interact with objects and their peers in this way allows teachers to reinforce thinking processes and evaluate any possible misunderstandings. Mathematical reasoning cannot develop in isolation. The ability to reason is a process that grows out of many independent and collaborative experiences that convince children that mathematics makes sense.

Standard 4: Mathematical Connections (K-12)

Children tend to think of mathematics as computation. One way to dispel this incorrect notion is to offer them more experiences with other topics; even so, unless connections are made, children will see mathematics as a collection of isolated topics. Only through extended independent and

collaborative exposure to integrated topics will children have a better chance of retaining the concepts and skills they are taught.

Standards 5-13 at the K-12 level and Standard 14 at the 9-12 level continue to imply the benefits of individual, whole group, and collaborative exploration of the various concepts within the framework of the mathematics standards.

National Committee on Science Education Standards and Assessment, ***National Science Education Standards***

Standard 1: Science as Inquiry (K-12)

The behaviors listed under this standard, because they involve asking, planning, developing, investigating, thinking critically, analyzing, and communicating, could either be demonstrated on an independent or collaborative basis. Although the nature of the inquiry is not stated directly as being independent or collaborative, either scenario will fit adequately.

Center for Civic Education, ***National Standards for Civics and Government***

Standard I A: What Are the Major Purposes of Government and What Is the Rule of Law? (5-8)

Students should be able to evaluate the implications for individuals and society of competing ideas regarding the purposes of government. To achieve this standard, students should be able to explain the major reasons why government is necessary: because life would be insecure without it; because individuals by themselves cannot do many of the things they can do collectively, e.g., make and enforce laws, create a system of highways.

OUTCOME #4: IDEAL STUDENTS ARE EXPERIENCED WITH REAL-LIFE APPLICATIONS.

INTENT: ***Perhaps this outcome, to a greater degree than the others, is dependent on the modeled behaviors and attitudes of the classroom teacher. It is the intention of the researcher that students at the K-12 levels for mathematics, science, and civics and government be provided with manifold opportunities to apply the discipline-specific facts, knowledge, and terminology to situations and events which have a direct impact on their lives and the lives of others.***

National Council of Teachers of Mathematics *Curriculum and Evaluation Standards for School Mathematics*

Standard 1: Mathematics as Problem Solving (K-4)

In grades K-4, the study of mathematics should emphasize problem solving so that students can formulate problems from everyday situations.

Standard 1: Mathematics as Problem Solving (5-8)

In grades 5-8, the mathematics curriculum should include numerous and varied experiences with problem solving as a method of inquiry and application so that students can formulate problems from situations within and outside mathematics.

Standard 1: Mathematics as Problem Solving (9-12)

In grades 9-12, the mathematics curriculum should include the refinement and extension of methods of mathematical problem solving so that all students can apply the process of mathematical modeling to real-world problem situations.

Standard 5: Number and Number Relationships (5-8)

In grades 5-8, the mathematics curriculum should include the continued development of number and number relationships so that students can understand, represent, and use numbers in a variety of equivalent forms (integer, fraction, decimal, percent, exponential, and scientific notation) in real-world problem situations.

Standard 6: Functions (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of functions so that all students can model real-world phenomena with a variety of functions.

Standard 7: Geometry from a Synthetic Perspective (9-12)

This component of the 9-12 geometry strand should provide experiences that deepen students' understanding of shapes and their properties, with an emphasis on their wide applicability in human activity. The curriculum should be infused with examples of how geometry is used in recreations (as in billiards or sailing); in practical tasks (as in purchasing paint for a room); in the sciences (as in the description and analysis of mineral crystals); and in the arts (as in perspective drawing).

Standard 8: Patterns and Functions (5-8)

In grades 5-8, the mathematics curriculum should include exploration of patterns and functions so that students can observe and describe all sorts

of patterns in the world around them: plowed fields, haystacks, architecture, paintings, leaves on trees, spirals on pineapples, and so on. The mathematics curriculum should help sensitize students to the patterns they meet every day and to the mathematical descriptions or models of these patterns and relationships.

Standard 9: Trigonometry (9-12)

In grades 9-12, the mathematics curriculum should include the study of trigonometry so that all students can explore periodic real-world phenomena using the sine and cosine functions and use circular functions to model periodic real-world phenomena.

Standard 10: Measurement (K-4)

Children can see the usefulness of measurement if classroom experiences focus on measuring real objects, making objects of given sizes, and estimating measurements. Textbook experiences cannot substitute for activities that use measurement to answer questions about real problems.

Standard 10: Statistics (5-8)

In grades 5-8, the mathematics curriculum should include exploration of statistics in real-world situations so that students systematically collect, organize, and describe data and construct, read, and interpret their statistical results.

Standard 10: Statistics (9-12)

In grades 9-12, the mathematics curriculum should include the continued study of data analysis and statistics so that all students can construct and draw inferences from charts, tables, and graphs that summarize data from real-world situations and understand sampling and recognize its role in statistical claims.

Standard 11: Probability (5-8)

In grades 5-8, the mathematics curriculum should include explorations of probability in real-world situations so that students can develop an appreciation for the pervasive use of probability in the real world.

Standard 12: Geometry (5-8)

The relationship between the angles and the sides of similar triangles is the foundation of trigonometry. Similarity also can be related to such real-world contexts as photographs, models, projections of pictures, and photocopy machines. Students should explore the relationships among the lengths, area, and volumes of similar solids. Symmetry in two and three dimensions provides rich opportunities for students to see geometry in the world of art, nature, construction, and so on.

Standard 13: Measurement (5-8)

Students encounter measurement ideas both in and out of school, in such areas as architecture, art, science, commercial design, sports, cooking, shopping, and map reading. The study of measurement shows the usefulness and practical applications of mathematics, and students' need to communicate about various measurements highlights the importance of standard units and common measurement systems.

National Committee on Science Education Standards and Assessment, *National Science Education Standards*

Standard 1: Science as Inquiry (K-12)

As a result of inquiry-oriented activities in grades K-12, all students should develop the ability to make real-life applications to scientific inquiries, investigations, explanations, analyses, and communications.

Center for Civic Education, *National Standards for Civics and Government*

Standard IV D: What Is the Relationship of the United States to Other Nations and to World Affairs? (K-4)

Students should be able to explain how and why events throughout the world have important effects on their own lives and on their community, state, and nation.

Standard IV B: What Is the Relationship of American Politics and Government to World Affairs? (5-8)

Students should be able to describe the influence of American political ideas on other nations. Students should be able to evaluate proposals for dealing with significant political, demographic, and environmental developments in the world.

Standard IV C: What Is the Relationship of American Politics and Government to World Affairs?

Students should be able to evaluate, take, and defend positions on the impact of American political ideas on the world.

Standard V: What Are the Roles of the Citizen in American Society? (K-4)

Students should be able to explain why personal, political, and economic rights are important to the individual and to a democratic society. Students should be able to explain the importance of individuals fulfilling their personal and public responsibilities in order for American democracy to flourish. Students should be able to explain how participating in public life may help American attain their individual and community goals.

Standard V, D: What Are the Roles of the Citizen in the American Political System? (5-8)

Students should be able to describe the means by which citizens may monitor and influence the formation and implementation of public policy by: becoming informed about public issues, discussing public issues, explaining why becoming knowledgeable about public affairs and the values and principles of American democracy and communicating that knowledge to others is a form of participation.

Standard V, D: What Are the Roles of the Citizen in the American Political System? (9-12)

Students should be able to explain the importance of knowledge to competent and responsible participation in American constitutional democracy by explaining the view that democracy is fragile and that it requires the participation of an attentive, knowledgeable, and competent citizenry.

OUTCOME #5: IDEAL STUDENTS ARE HISTORICALLY EQUIPPED.

INTENT: ***Students will demonstrate a knowledge of the historical backgrounds of the disciplines of mathematics, science, and civics and government, so as to gain an appreciation for the developmental processes through which each discipline evolved that they may become lifelong learners, using the best knowledge from the past and applying it to their futures.***

National Council of Teachers of Mathematics ***Curriculum and Evaluation Standards for School Mathematics***

Standard 13: Conceptual Underpinnings of Calculus

The development of the calculus represents one of the great intellectual accomplishments in human history; perhaps the greatest achievement in the application of mathematics is the use of calculus in physics during the first third of this century. As students explore the topics presented with calculus, it is important that they develop an awareness of, and appreciation for, the historical origins and cultural contributions of the calculus.

National Committee on Science Education Standards and Assessment
National Science Education Standards

Standard 7: History and Nature of Science (K-12)

As a result of activities in grades K-12, all students should develop an understanding of science as a human endeavor.

Center for Civic Education ***National Standards for Civics and Government***

Standard I: What Is Government and What Should It Do? (5-12)

Students should be able to cite historical and contemporary examples of the purposes and characteristics of limited and unlimited government, the ideas about the nature and purposes of constitutions, and the means of organizing governments.

Standard II: What Are the Foundations of the American Political System? (5-12)

Students should be able to describe the major political events which led to the creation of limited governments throughout the world and describe the historical documents events, diversity of cultures, attitudes, and values which led to the founding of the American political system.

Standard III: How Does the Government Established by the Constitution Embody the Principles and Purposes of American Democracy? (5-12)

Students should explain how the Framers of the Constitution drew on their knowledge of history and philosophy as well as their own experience in designing the Constitution. Case studies should be used to illustrate how American government functions at national, state, and local levels.

Standard IV: What Is the Relationship of American Politics and Government to World Affairs? (5-12)

Concerning the historical context of United States foreign policy, students should be able to explain the principal foreign policy positions the United States has taken and evaluate their consequences.

OUTCOME #6: IDEAL STUDENTS ARE IN TUNE WITH THE WORLD AROUND THEM.

INTENT: ***Students will perceive themselves as possessing a dual citizenship as citizens of the United States and citizens of the Earth. The students should recognize how the actions individuals, businesses, and nations take can and do impact the global society in which they live in positive and negative ways.***

National Council of Teachers of Mathematics ***Curriculum and Evaluation Standards for School Mathematics***

Standard 4: Mathematical Connections (K-4)

In grades K-4, the study of mathematics should include opportunities to make connections so that students can integrate the language arts and mathematics as they write about and discuss their experiences in mathematics. As children solve problems in mathematics classes, they can be learning about other countries and cultures.

Standard 4: Mathematical Connections (5-8)

As students in grades 5-8 become aware of the world around them, probability and statistics become increasingly important connections between the real world and the mathematics classroom Weather forecasting, scientific experiments, advertising claims, chance events, and economic trends are but a few of the areas in which students can investigate the role of mathematics in our society and others.

Standard 4: Mathematical Connections (9-12)

Students' understanding of the connections among mathematical ideas facilitates their ability to formulate and deductively verify conjectures across topics. In turn, these newly developed mathematical concepts and procedures can be applied to solve other problems arising from within mathematics and other disciplines, such as business [the optimization of a global communications network], medicine [modeling an inoculation plan to eliminate an infectious disease], or social science [using statistical techniques in predicting and analyzing domestic and foreign election results].

National Committee on Science Education Standards and Assessment

National Science Education Standards

Standard 5: Science and Technology (K-12)

As a result of activities in grades K-12, all students should develop the ability to perceive how scientific discoveries and improvements and technological advances have a global effect.

Standard 6: Science and Societal Challenges (K-4)

As a result of activities in grades K-4, all students should develop an understanding of types of resources, changes in environments, and personal actions.

Standard 6: Science and Societal Challenges (5-8)

As a result of activities in grades 5-8, all students should develop an understanding of populations, resources, and environments in all societies; natural hazards, technology and society; risks and benefits; and personal decision making.

Standard 6: Science and Societal Challenges (9-12)

As a result of activities in grades 9-12, all students should develop an understanding of population growth, natural resources, environmental degradation, natural and human-induced hazards, community health, global changes, and science, technology, and public policy.

Center for Civic Education *National Standards for Civics and Government*

Standard IV: What Is the Relationship of the United States to Other Nations and to World Affairs? (K-4)

Students should be able to explain that the world is divided into different nations which interact with one another and the major ways nations interact with one another.

Standard IV: What Is the Relationship of American Politics and Government to World Affairs? (5-8)

Students should be able to describe how the world is organized politically and explain how nation-states interact with each other. Students should be able to describe the influence of American political ideas on other nations.

Standard IV: What Is the Relationship of American Politics and Government to World Affairs? (9-12)

Students should be able to describe how the world is organized politically and explain how nation-states interact with each other. Students need to be conversant with international affairs and global issues that directly or indirectly play a major role in their lives. As Americans students need to understand that the nation does not exist in isolation; it is part of an interconnected world in whose development the United States has played and continues to play a considerable role.

Standard V: What Are the Roles of the Citizen in American Democracy? (K-4)

Students should be able to describe the means by which citizens can influence the decisions and actions of their government by becoming informed about public and global issues, discussing public and global issues, communicating with public officials, and voting.

OUTCOME #7: IDEAL STUDENTS ARE CONNECTION MAKERS WITHIN AND ACROSS THE DISCIPLINES.

INTENT: ***For too many students knowledge gained within one discipline is detached from other knowledge within that discipline and from the other disciplines as well. Students should continually and actively make academic and real-world connections with the knowledge they gain, so that they internalize learning and become lifelong learners.***

National Council of Teachers of Mathematics *Curriculum and Evaluation Standards for School Mathematics*

Standard 3: Mathematics as Reasoning (9-12)

It is important that students recognize the difference between a statement

that is verified by mathematical proof (i.e. a theorem) and one that is verified empirically using statistical arguments. A discussion of these reasoning issues can serve as a connection between mathematics and social studies classes in which the (usually negative) social consequences of stereotyping are studied.

Standard 4: Mathematical Connections (K-4)

In grades K-4, the study of mathematics should include opportunities to make connections so that students can relate various representations of concepts or procedures to one another, recognize relationships among different topics in mathematics, and use mathematics in other curriculum areas.

Standard 4: Mathematical Connections (5-8)

In grades 5-8, the mathematics curriculum should include the investigation of mathematical connections so that students can see mathematics as an integrated whole; use a mathematical idea to further their understand of other mathematical ideas; and apply mathematical thinking and models in solving problems that arise in other disciplines, such as art, music, psychology, science, and business.

Standard 4: Mathematical Connections (9-12)

In grades 9-12, the mathematics curriculum should include investigations of the connections and interplay among various mathematical topics and their applications so that all students can relate procedures in one representation to procedures in an equivalent representation, use and value the connections among mathematical topics, and use and value the connection between mathematics and other disciplines.

Standard 5: Estimation (K-4)

In grades K-4, the curriculum should include estimation so students can explore estimation strategies and apply estimation in working with quantities, measurement, computation, and problem solving.

Standard 5: Number and Number Relationships (5-8)

To provide students with a lasting sense of number and number relationships, learning should be grounded in experience related to aspects of everyday life or to the use of concrete materials designed to reflect underlying mathematical ideas. Students should encounter number lines, area models, and graphs as well as representations of number that appear on calculators and computers. Students should learn to identify equivalent forms of a number and understand why a particular representation is useful in a given setting.

Standard 6: Number Systems and Number Theory (5-8)

Number theory offers many rich opportunities for explorations that are interesting, enjoyable, and useful. These explorations have payoffs in problem solving, in understanding and developing other mathematical concepts, in illustrating the beauty of mathematics, and in understanding the human aspects of the historical development of number. Without an understanding of number systems and number theory, mathematics is a mysterious collection of facts. With such an understanding, mathematics is seen as a beautiful, cohesive whole.

Standard 8: Trigonometry (9-12)

In grades 9-12, the mathematics curriculum should include the study of trigonometry so that college-bound students can understand the connection between trigonometric and circular functions and understand the connection between trigonometric functions and polar coordinates, complex numbers, and series.

Standard 10: Measurement (K-4)

In grades K-4, the mathematics curriculum should include measurement so that students can understand the attributes of length, capacity, weight, mass, area, volume, time, temperature, and angle; and develop the process of measuring and concepts related to units of measurement.

Standard 11: Statistics and Probability (K-4)

In grades K-4, the mathematics curriculum should include experiences with data analysis and probability so that students view statistics and probability as important links to other content areas, such as social studies and science. They also can reinforce communication skills as children discuss and write about their activities and their conclusions.

Standard 12: Geometry (5-8)

Symmetry in two and three dimensions provides rich opportunities for students to see geometry in the world of art, nature, construction, and so on.

Standard 13: Measurement (5-8)

Constructing scale models involves proportional reasoning and connects mathematics to other disciplines. Students can use their knowledge of similar triangles to measure heights of inaccessible objects. Measurement experiences are a powerful mathematical connection among topics in the middle school curriculum and in other disciplines. Measurement clearly shows the usefulness of mathematics in everyday life.

Standard 14: Mathematical Structure (9-12)

In grades 9-12, the mathematics curriculum should include the study of

mathematical structure so that all students can compare and contrast the real number system and its various subsystems with regard to their structure characteristics, understand the logic of algebraic procedures, and appreciate that seemingly different mathematical systems may be essentially the same.

National Committee on Science Education Standards and Assessment
National Science Education Standards

Standard 5: Science and Technology (K-12)
The Science and Technology standard establishes useful connections between the natural world and the designed world and offers essential decision-making abilities.

Standard 8: Unifying Concepts and Processes (K-12)
The Unifying Concepts and Processes standard provides students with powerful ideas that help them understand the natural world. These conceptual and procedural schemes are integral to students' science learning experiences. The understanding and abilities associated with this standard should be developed over the entire K-12 continuum. All students should develop an understanding of and ability to use the following concepts and processes: systems, organization, form and function, interactions, change, measurement, models, scale, diversity, adaptation and evolution, and explanation.

Center for Civic Education ***National Civics and Government Standards***

Standard V: What Are the Roles of the Citizen in American Democracy? (K-4)
Students should be able to explain the meaning of citizenship in the United States, the importance of individuals assuming their personal and public responsibilities, and how participating in public life may help Americans attain their individual and community goals.

Standard V: What Are the Roles of the Citizen in the American Political System? (5-12)
Students should be able to evaluate, take, and defend positions on the meaning of American citizenship, on issues involving personal, political, and economic rights, and on the relationship between politics and the attainment of individual and public goals.

OUTCOME #8: IDEAL STUDENTS ARE RISK TAKERS AS WELL AS SELF-MONITORS.

INTENT: ***This student outcome is essentially a companion to outcomes 2 and 3. It is the hope of the researcher that in academic contexts and lifelong learning situations,***

students will be willing to conjecture, to succeed or fail, and to learn from their experiences with successes and failures. Students should be encouraged to attempt to solve problems which may have multiple solutions or no solutions at all. Throughout the learning process, students should be continually monitoring their learning by asking questions, collaborating with peers, and reflecting on their experiences by keeping journals.

National Council of Teachers of Mathematics *Curriculum and Evaluation Standards for School Mathematics*

Standard 1: Mathematics as Problem Solving (K-12)

In grades K-12, the study of mathematics should emphasize problem solving so that students can learn to value the process of solving problems as much as they value the solutions. Problem solving is the process by which students experience the power and usefulness of mathematics in the world around them. In the middle and upper grades, students should sample data, analyze and make predictions on the basis of their samples, make conjectures, discuss and validate their conclusions, and prepare arguments to convince others of their conclusions. Students also should experience problem situations rich in opportunities to formulate and define problems, determine the information required, decide on methods for obtaining this information, and determine the limits of acceptable solutions.

Standard 3: Mathematics as Reasoning (K-4)

In grades K-4, the study of mathematics should emphasize reasoning so that students recognize that being able to explain and justify their thinking is important and that how a problem is solved is as important as its answer.

Standard 3: Mathematics as Reasoning (5-8)

In grades 5-8, reasoning shall permeate the mathematics curriculum so that students can make and evaluate mathematical conjectures and arguments and validate their own thinking.

Standard 3: Mathematics as Reasoning (9-12)

In grades 9-12, the mathematics curriculum should include numerous and varied experiences that reinforce and extend logical reasoning skills so that all students can make and test conjectures.

Standard 7: Computation and Estimation (5-8)

Students should possess adequate mental arithmetic skills so that they are not dependent on calculators to do simple computations and are able to detect unreasonable answers when using calculators to solve harder computations. This standard concentrates on teaching students to use

computations in context, to frame and execute computations using different methods, and to estimate.

Standard 7: Geometry from a Synthetic Perspective (9-12)

This standard emphasizes the interplay between deductive and inductive experiences to propose answers to geometric problem situations and verify a discovery through a deductive argument.

Standard 10: Statistics (5-8)

In grades 5-8, the mathematics curriculum should include exploration of statistics in real-world situations so that students can make inferences and convincing arguments that are based on data analysis.

Standard 11: Probability (K-12)

The nature of probability encourages a systematic and logical approach to problem solving. Throughout their experimentation and simulation, students should be making hypotheses, testing conjectures, and refining their theories on the basis of new information. Probability also can be applied to data analysis. Students can use charts, graphs, and plots to make predictions; this activity reinforces their interpretation of the information and their derivation of other useful information.

Standard 12: Geometry (5-8)

In grades 5-8, the mathematics curriculums should include the study of the geometry of one, two, and three dimensions so that students can discover relationships and develop spatial sense by constructing, drawing, measuring, visualizing, comparing, transforming, and classifying geometric figures. Discussing ideas, conjecturing, and testing hypotheses precede the development of more formal summary statements.

National Committee on Science Education Standards and Assessment

National Science Education Standards

Standard 1: Science as Inquiry (K-12)

The Science as Inquiry standard should be recognized as a basic and controlling principle in the ultimate organization and experiences in students' science education. This standard on inquiry highlights the ability to do inquiry. As a result of inquiry-oriented activities in grades K-12, all students should be able to plan and conduct investigations, gather data, construct explanations, and analyze and communicate their findings.

Chapter Three

Results & Implications

The researcher did find that it was indeed possible to synthesize a concise set of exit outcomes which correlated to the national content standards for mathematics, science, and civics and government. Readers of this research may make efforts to attain the exit outcomes for the students in their school or district.

However, the researcher does encourage all individuals involved in educating elementary, middle school, and secondary students to consider reading the national standards for each of the disciplines in their entirety. One cannot begin to appreciate the tremendous effort expended to produce the national standards until he or she reads them.

The researcher also perceived a need for continued development in the researching of the national standards. The very nature of the word *standard* implies evaluation. Yet only the National Council of Teachers of Mathematics includes standards for evaluation within its curriculum publication. The National Committee on Science Education Standards and Assessment makes reference to assessment standards which "specify criteria for assessing and analyzing students' attainments in science and the opportunities to learn that school science programs afford students" (*National Science Education Standards*, 2). And although reference is made to these assessment standards, actual methods to measure student proficiency on the various behaviors suggested by the science standards are not directly stated. The Center for Civic Education leaves the development of assessment standards to "assessment specialists," who reside in the school districts where the standards will be adopted (*National Standards for Civics and Government*, 9-12, xviii).

The standards with which the researcher dealt were not intended to be course outlines for the disciplines of mathematics, science, and civics and government, but rather "exit standards for grade twelve. The standards represent the cumulative knowledge and skills which a student should acquire over the course of thirteen years of schooling from kindergarten through grade twelve" (Center for Civic Education, 9-12, ix). Yet educators and administrators may wonder that although the standards are complete in content and focus, how can they be implemented and judged worthy? Evaluation and assessment standards must accompany the content standards for each of the disciplines.

"As we need standards for curricula, so we need standards for assessment. We must ensure that tests measure what is of value, not just what is easy to test. If we want students to investigate, explore, and discover, assessment must not measure just mimicry. By making testing more important than learning, present practice holds today's students hostage to yesterday's mistakes" (National Research Council, 70).

The guidelines for student assessment which follow are merely a springboard for manifold possibilities of measuring the depth and breadth of student learning and mastery of the content standards.

STANDARD PROCEDURE

Since assessment is directly connected to educational standards and their implementation, the researcher would like to suggest the following fundamental guidelines for assessing student performance as compared to the exit outcomes. These guidelines are by no means original, and most are taken directly from *Curriculum and Evaluation Standards for School Mathematics*. The assessment guidelines are interdisciplinary.

OUTCOME #1: IDEAL STUDENTS ARE DISCIPLINE AND TECHNOLOGY LITERATE, ABLE TO PARTICIPATE AND COMMUNICATE.

To evaluate this outcome, educators will have to present students with tasks that focus on specific skills, types of procedures, concepts, strategies, or types of reasoning. When assessment reflects technological aspects of instruction, such as the use of manipulatives, calculators, and computers, these materials should be available during the assessment procedures. Assessment procedures may include teacher observation, oral questions which require students to explain their procedures, focused written tasks, or directed test items.

OUTCOME #2: IDEAL STUDENTS ARE CREATIVE THINKERS, PROBLEM FORMULATORS, AND PROBLEM SOLVERS.

To evaluate this outcome, educators will have to present students with tasks that require an integration of knowledge, rather than rote recall. These tasks should cover a range of skills, concepts, and procedures, and require the application of learning to new contexts. Problem-solving and reasoning tasks should have varied formats and contexts. To assess student proficiency, educators may make use of written tests, including those that require differential methods for solutions to problems; oral presentations; extended problem-solving projects; observation of student participation in class discussions; or journals, where students will explain and reflect on their thought processes.

OUTCOME #3: IDEAL STUDENTS ARE INDEPENDENT AS WELL AS COLLABORATIVE LEARNERS.

To evaluate this outcome, educators will have to introduce students to situations where they will be required to work on long-term and short-term tasks independently or in collaborative situations. To assess student proficiency, educators may make use of personal observation in search of specific behaviors, interactive peer evaluations, or journals, where students will reflect upon their independent and collaborative experiences.

OUTCOME #4: IDEAL STUDENTS ARE EXPERIENCED WITH REAL-LIFE APPLICATIONS.

To evaluate this outcome, educators will have to present students with tasks which require them to structure the material and generate solutions in the context of the real world. Tasks will have to be intrinsically interesting and challenging to the students and demand integration of the material that was taught. To assess student proficiency, educators may make use of extended problem-solving projects, papers or written arguments which require thoughtful inquiry, written tests which present problems with a range of difficulty, class presentations, interviews, or journals.

OUTCOME #5: IDEAL STUDENTS ARE HISTORICALLY EQUIPPED.

To evaluate this outcome, educators will have to present students with tasks which require an integration of knowledge and which cover a range of skills, concepts, and procedures. These tasks may involve problem-solving or reasoning techniques and should require the application of learning to new contexts. To assess student proficiency, educators may make use of oral presentations, moderated classroom debates, personal interviews, student participation in classroom discussions, extended research projects, collaborative problem-solving efforts, written tests, or journals.

OUTCOME #6: IDEAL STUDENTS ARE IN TUNE WITH THE WORLD AROUND THEM.

To evaluate this outcome, educators will have to present students with tasks which demand the integration of the material that was taught and which require the students to structure the material and generate solutions in the context of the world as a whole. To assess student proficiency, educators may make use of student participation in class discussions, oral presentations, moderated classroom debates, extended research projects, personal interviews, focused written tasks, collaborative problem-solving efforts, or journals.

OUTCOME #7: IDEAL STUDENTS ARE CONNECTION MAKERS WITHIN AND ACROSS THE DISCIPLINES.

To evaluate this outcome, educators will have to present students with tasks which require an integration of knowledge and which cover a range of skills, concepts, and procedures. These tasks should require the application of learning to new contexts and should provide for connection-making within and across the disciplines. To assess student proficiency, educators may make use of written tests, including those which require differential methods for solutions to problem

solving, oral and written presentations, personal interviews, direct observation, oral questioning which requires students to explain their reasoning, individual and collaborative problem-solving tasks, or journals.

OUTCOME #8: IDEAL STUDENTS ARE RISK TAKERS (WITHIN ACADEMIC CONTEXTS) AS WELL AS SELF-MONITORS.

To evaluate this outcome, educators will have to present students with opportunities and problem situations which require an integration of knowledge and include the process of inquiry. To assess student proficiency, educators may make use of independent and collaborative problem-solving tasks, personal interviews, peer evaluations, attitudinal surveys, or interactive journaling.

Annotated Bibliography

Center for Civic Education. *National Standards for Civics and Government.* Calabassas, CA: Center for Civic Education, 1993 (9-12 draft), 1994 (K-4 & 5-8 drafts).

The Center for Civic Education has amassed exit standards for a K-12 education system which represent the knowledge in civics and government a student should have acquired by the time he or she leaves the terminal grade of an educational system. The drafts are limited to content standards and, in the 9-12 standards, rationales which explain the need for knowing the content are contained in the publications.

Evans, David. "Congressional Support for Civic Education." Speech presented at "We the People . . . The Citizen and the Constitution," National Conference for State and District Coordinators. Arlington, VA, June 28, 1994.

David Evans is the Staff Director for the United States Senate Subcommittee on Education, Arts, and the Humanities and commented in his speech on the lack of integration of the national education standards within the public school system.

National Center for Education Statistics. *Can Students Do Mathematical Problem Solving?* Washington, D.C.: Educational Testing Service, 1993.

This statistical publication documents the performance of some 250,000 fourth-, eighth-, and twelfth- graders from nearly 10,000 U.S. schools on standardized mathematical tasks. Results are communicated on the basis of demographics, race, ethnicity, and gender. Specific student responses are cited and categorized as incorrect responses, correct responses, and extended responses. Overall, U.S. students need to receive improved mathematics instruction, more time during the school day for problem-solving activities, and greater adherence to the NCTM *Standards* in order to improve their mathematics proficiency. This publication will aid those educators who will implement the NCTM *Standards*, as it presents specific multi-step problems which can be applied in classroom settings.

National Center for Education Statistics. *Trends in Academic Progress.* Washington, D.C.: Educational Testing Service, 1991.

This statistical publication documents the academic performance of U.S. students, age 9, 13, and 17, for the years 1970 to 1990 for science, and the years 1973 to 1990 for mathematics. Students performances were rated on proficiency scales for science and mathematics which ranged from 0 to 500. Data was presented verbally and graphically based on overall trends, trends for demographic subpopulations, and race/ethnicity.

National Committee on Science Education Standards and Assessment. *National Science Education Standards,* (draft discussion summary). Washington, D.C.: National Research Council, 1994.

Presented in outline form, the suggested K-12 standards for science

education stress what it means to be scientifically literate. The standards represent a nationwide agreement on what defines successful science learning and the educational practices which support that learning. Included in the standards are science program standards, science teaching standards, science content standards, science assessment standards, and science system standards.

National Council of Teachers of Mathematics. *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA: The National Council of Teachers of Mathematics, 1989.

This document upholds the premise that American school children at the K-12 level need to learn more, and often different, mathematics and that instruction in mathematics must be significantly revised. Stress is placed on mathematical literacy and use of technology as well as the integration of the mathematics content standards within the discipline and into other disciplines. The final section of the publication includes content evaluation standards and suggestions on how educators may evaluate student proficiency as compared to the content standards.

National Diffusion Network. *Mathematics, Science, & Technology Education Programs that Work*. Washington, D.C.: National Diffusion Network, 1994.

Included in this publication are 64 education programs available for purchase and implementation in K-12 school districts. The programs, as the publication title suggests, stress enhanced incorporation of math, science, and technology within the classroom. The publication lists the name of each program, its grade level, the content of the program, the instructional emphasis, the curriculum scope, the number of days required for instructor training, and suggestions for professional development and inservices. This publication will aid educators who are interested in fulfilling the national standards for mathematics and science education by giving concrete examples of tested programs and resource personnel which can enhance educational opportunities.

Regional Educational Laboratories. *Promising Practices in Mathematics & Science Education*. Charleston, WV: Regional Eisenhower Consortia and National Clearinghouse, 1992.

The 66 educational programs listed in this publication present practical methods which will improve mathematics and science education within school buildings and districts. The programs are compared to checklists of 10 of the National Center for Improving Science Education (NCISE) standards and 9 NCTM standards. The program layouts include the topic, the users, the target population, what is emphasized, a general program description, the grade level, needed resources, funding methods, and contact personnel throughout the United States. Math programs, science programs, and integrated programs are presented in this useful guide.

South Dakota National Science Foundation Systemic Initiative. *South Dakota Mathematics & Science Benchmarks*. Pierre, SD: South Dakota National Science Foundation Systemic Initiative, 1993.

The benchmarks set visions for student learning and place emphases on learning. They do not separate math and science into discrete disciplines but rather address knowledge and competencies common to discipline literacy across all subjects. The document also stressed the use of technology in education and included integrated mathematics and science benchmarks as well.

Additional Source

National Research Council. *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*. Washington, D.C.: National Academy Press, 1989.